

# **Arc Flash Hazard and Electrical Safety**

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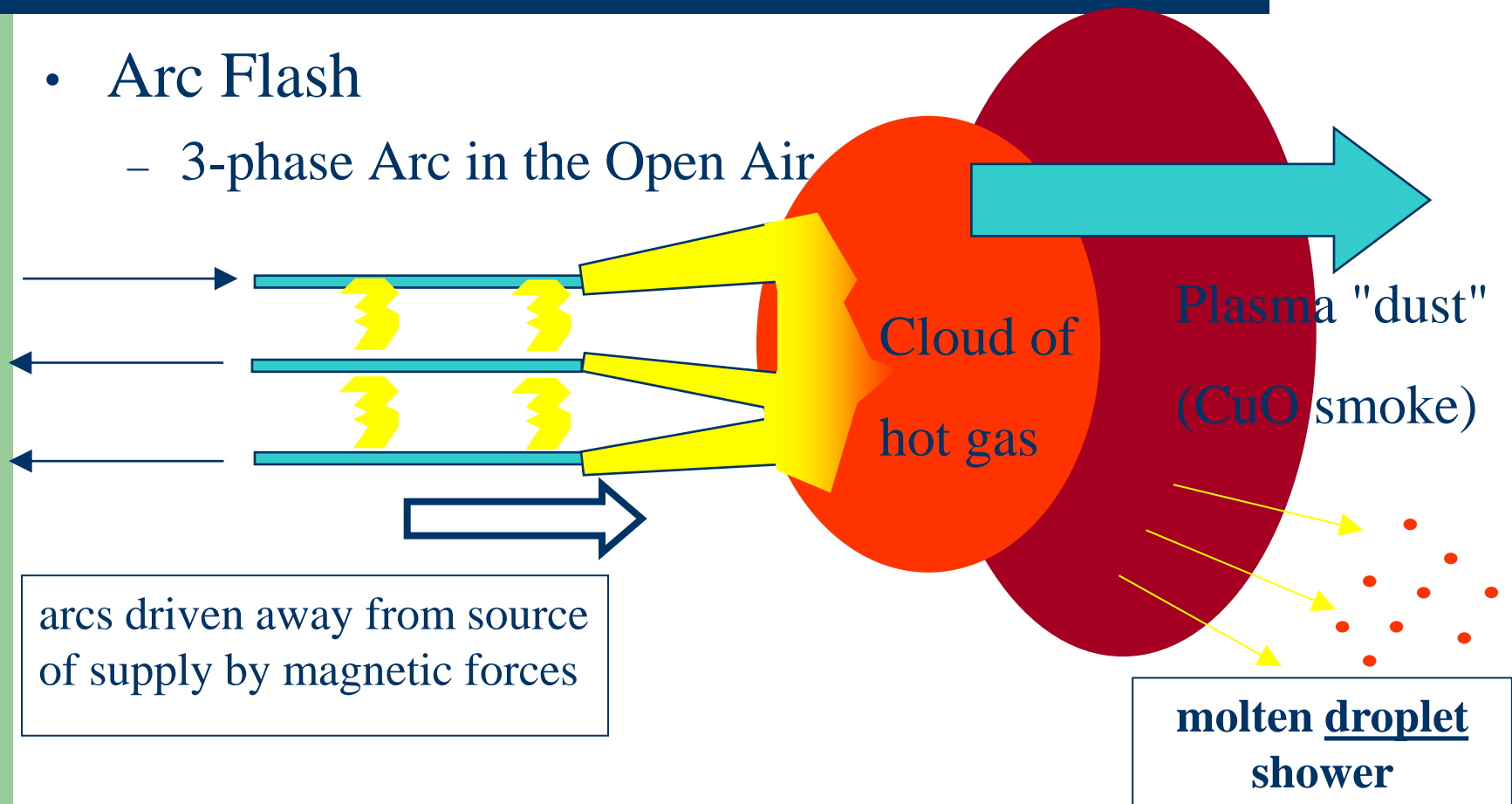
# Introduction

- Arc Flash
  - Arc flash is a sudden release of heat and energy caused by an electric arc.
  - The result of the violent event can cause destruction of equipment, fire, and injury not only to the worker but also to nearby people.



# Introduction

- Arc Flash
  - 3-phase Arc in the Open Air



# Risk Category

- Risk Category

Risk Category	Maximum cal/cm <sup>2</sup>	Clothing Requirement
0	[<1.2]	Natural fabric, 4.5+ oz/yd <sup>2</sup>
1	4	FR shirt/pants or FR coverall
2	8	FR shirt/pants or FR coverall
3	25	FR shirt/pants or FR coverall & flash suit
4	40	FR shirt/pants or FR coverall & flash suit

0 – 4 Safety glasses/goggles, Hearing protection

1 – 4 Hard hat, Leather gloves, Face shield/flash suit hood

2 – 4 Leather shoes

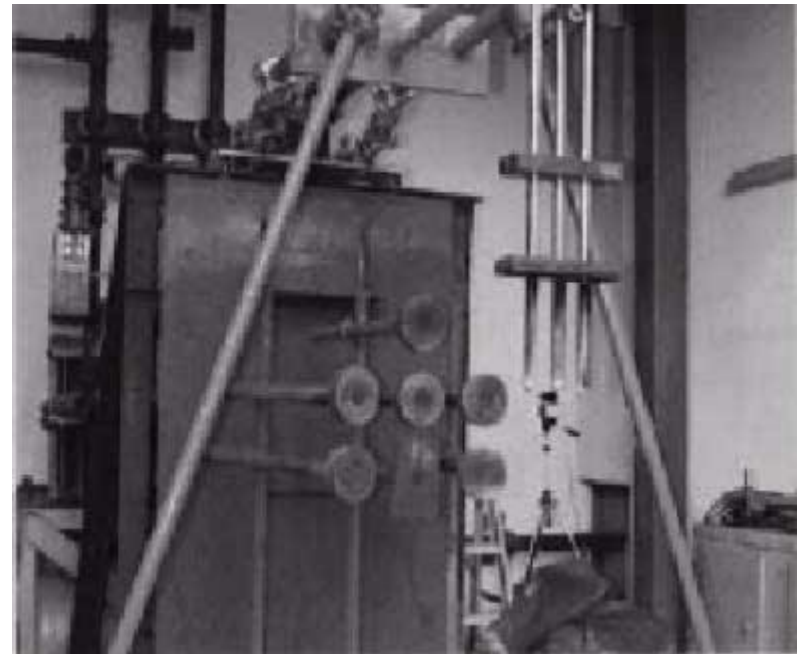
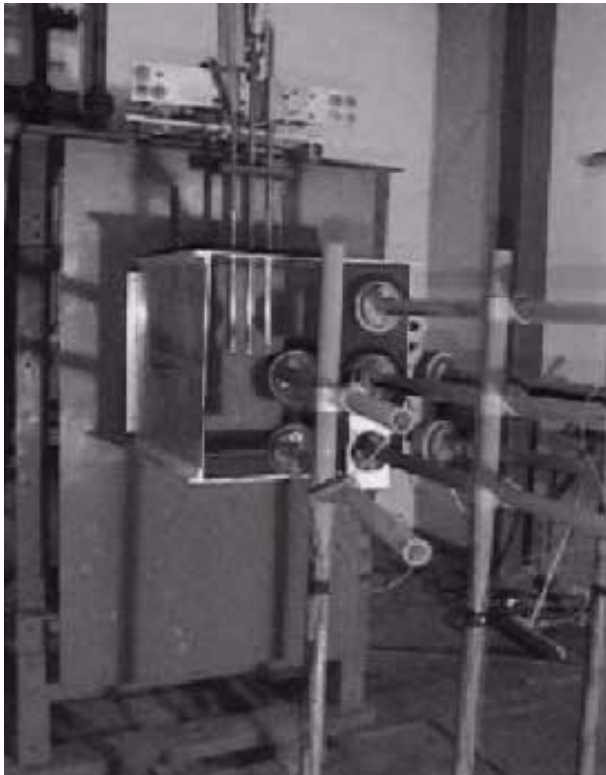
# Personal Protection Equipment

- Risk Category
  - Sample PPE



# IEEE 1584-2002

- Available Configurations



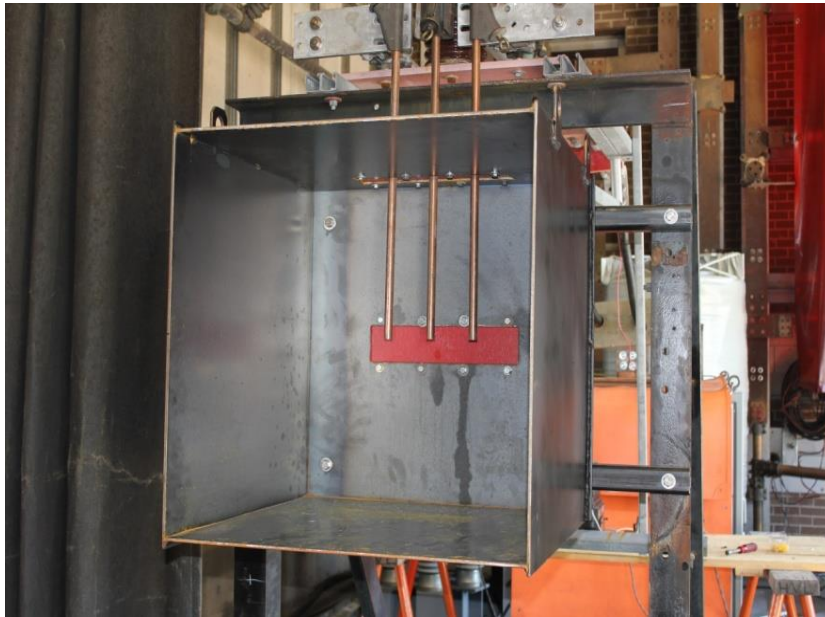
Source: IEEE Std. 1584-2002

# Important Factors to be Considered

- Bolted fault current level.
- Duration of the arc.
- Voltage level.
- Electrode Orientation/Configuration (VCB, VCB-Barrier, HCB, VOA, HOA).
- Gap width between electrodes.
- Calorimeter arrangement and measurement locations.
- Distance between electrode and back panel\*.
- Dimensions of the metal enclosure\*\*.



# Available Configurations for the Proposed New Model



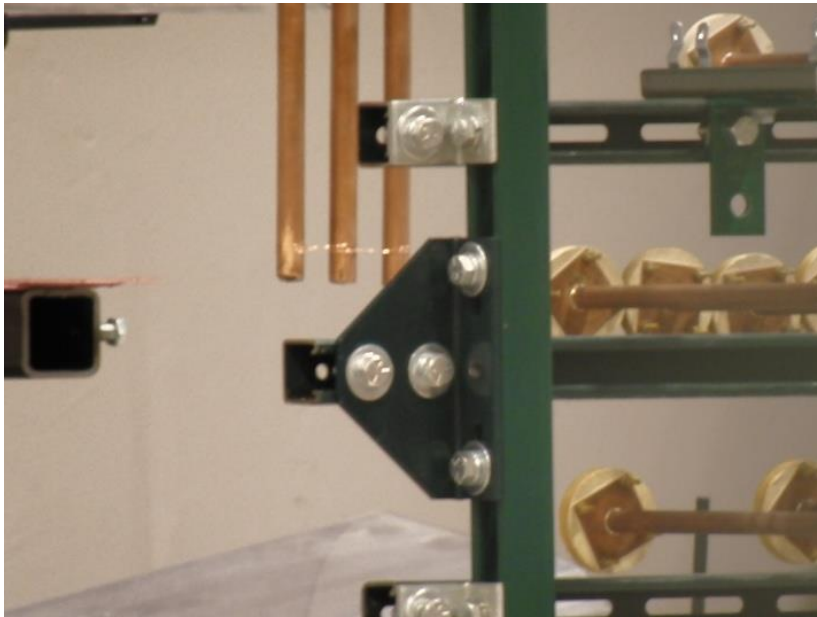
**Vertical Electrodes in the Cubic Box**  
**Electrodes are Terminated in the**  
**Middle of the Box**  
**(VCB)**



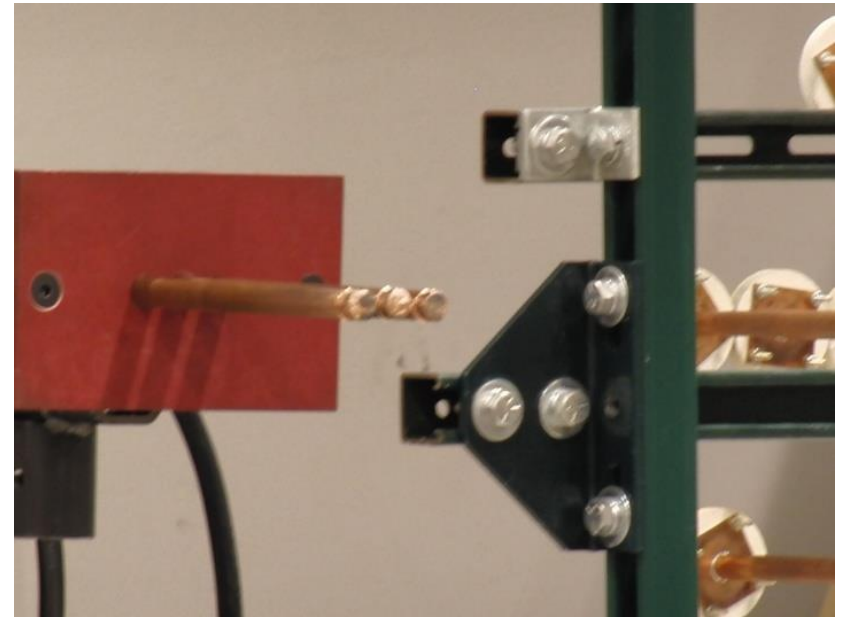
**Vertical Electrodes in the Cubic Box**  
**Electrodes are Terminated at the**  
**Bottom of the Box**  
**(VCBB)**



# Available Configurations for the Proposed New Model



**Vertical Electrodes in the Open Air  
(VOA)**



**Horizontal Electrodes in the Open Air  
(HOA)**

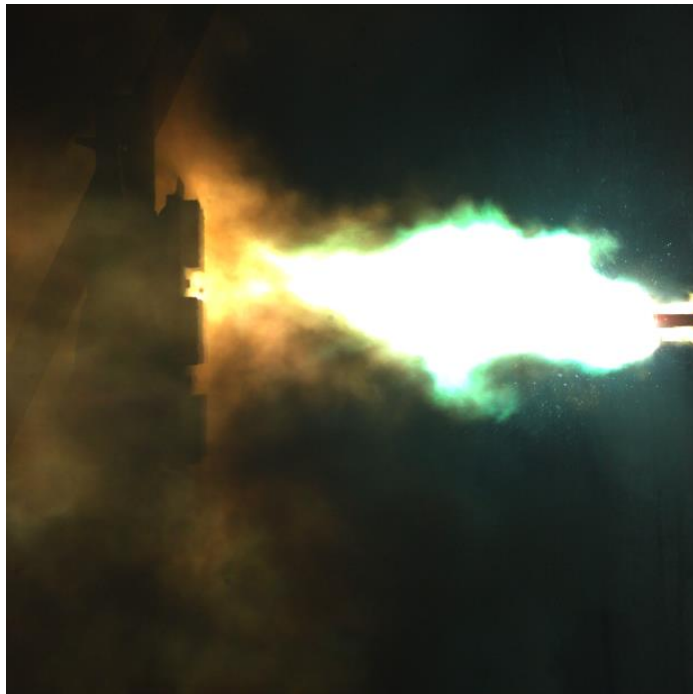
# Available Configurations for the Proposed New Model



**Horizontal Electrodes in the Cubic Box  
(HCB)**

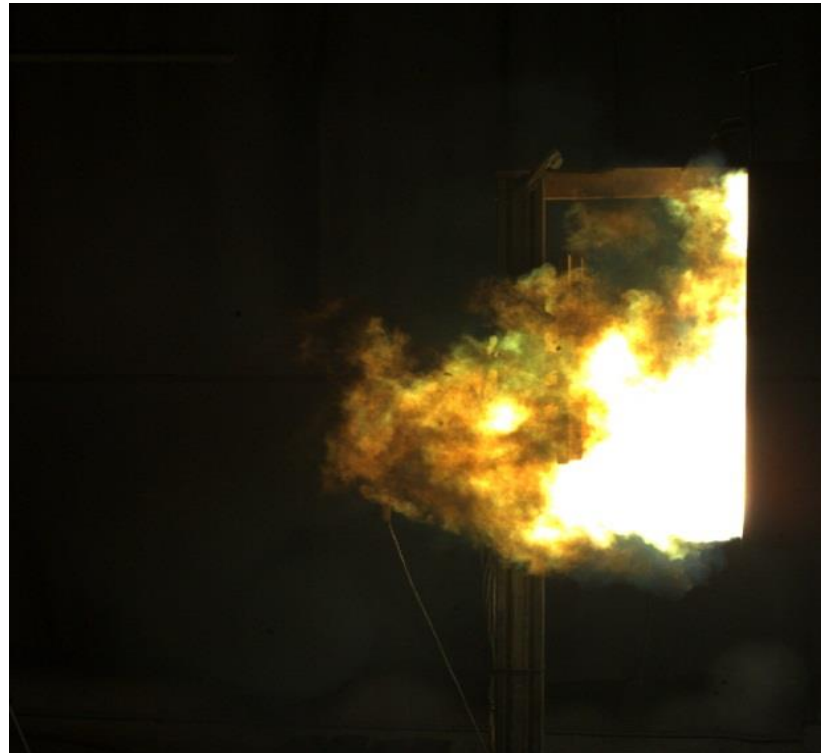
# Observation from the Testing

- Plasma Trajectories for Horizontal (HOA) and Vertical (VOA) Configurations



# Observation from the Testing

- Plasma Trajectory for Vertical (VCBB) Configuration



# Newly Developed Iarc, IE, Arc Flash Protection Boundary Calculator

IEEE1584 ExcelCalculator\_Version 2.5.1\_User Define.xlsm - Excel

FILE HOME INSERT PAGE LAYOUT FORMULAS DATA REVIEW VIEW ACROBAT

Clipboard Font Alignment Number Styles Cells Editing

D13

**Data Entry Instruction**

1. Column C is the title of each required parameter
2. Please input data into "Blue" fields in the Column D
3. Data input range please follow the description in "Basic Instruction"
4. Column F is the title of Estimated results
5. Column G show the estimated results corresponding to each title, which use "red" characters in "yellow" cell. **Do Not Edit Those Fields!**

**Equipment Configuration Class**

- 1-Vertical Electrodes in Cubic Box (VCB)
- 2-Barrier Test. Vertical Electrodes in Cubic Box (VCBB)
- 3-Horizontal Electrodes in Cubic Box (HCB)
- 4-Vertical Electrodes in Open Air (VOA)
- 5-Horizontal Electrodes in Open Air (HOA)

**Box Size Guidance Corresponding to Voltage Level**

Open Circuit Voltage (kV)	Box Size (W*H*D)
0.6	20"*20"*20"
2.7	26"*26"*26"
14.3	36"*36"*36"

Configuration (Num)	
Open Circuit Voltage (kV)	14.3
Bolted Fault Current (kA)	65
Electrode Gap (mm)	76.2
Working Distance (mm)	609.6
Arc Duration (ms)	100
Box_Width (inch)	36
Box_Height (inch)	36
Box_Depth (inch)	36

**Equipment Configuration Class**

- 1-Vertical Electrodes in Cubic Box (VCB)
- 2-Barrier Test. Vertical Electrodes in Cubic Box (VCBB)
- 3-Horizontal Electrodes in Cubic Box (HCB)
- 4-Vertical Electrodes in Open Air (VOA)
- 5-Horizontal Electrodes in Open Air (HOA)

Average Arcing Current (kA)	
Incident Energy (cal/cm2)	12.32
Flash-Protection Boundary (mm)	2691.95
User Defined Iarc	52.89
Exit of User Defined Iarc	

Basic Information Arc Flash Calculator Calculate Table

READY

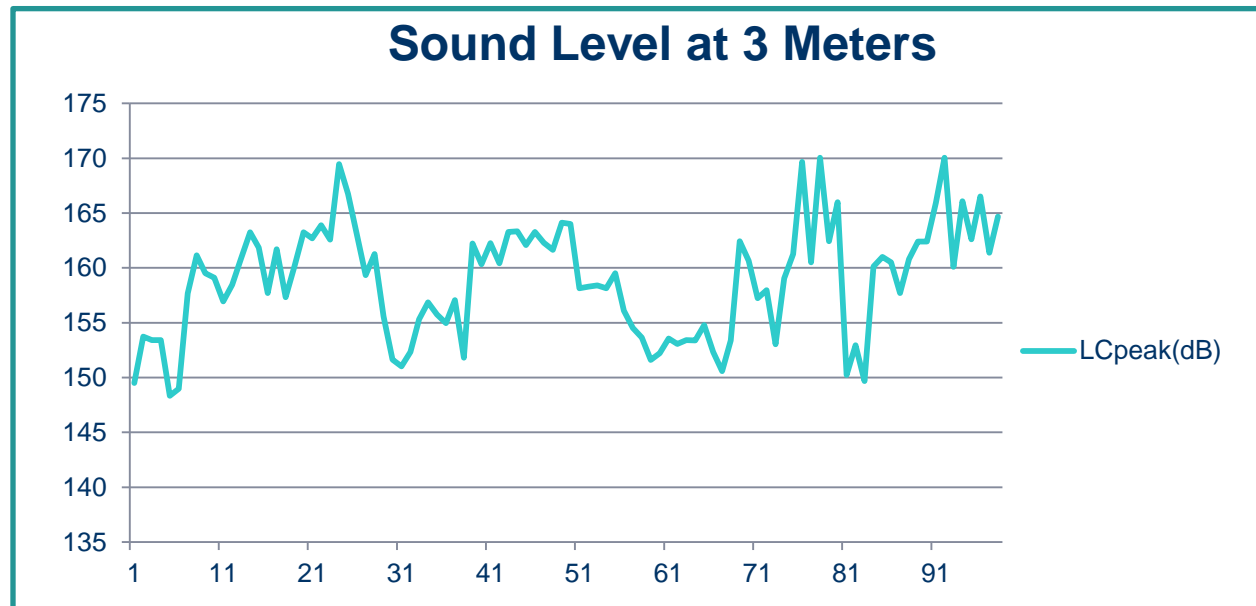
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# **Non-Thermal Related Hazards**

# Sound

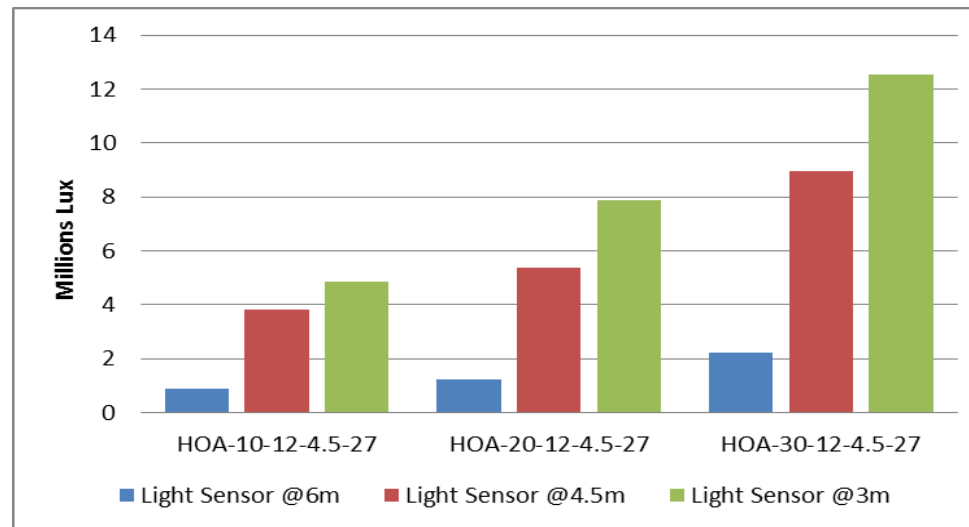
- Peak Sound Pressures for Medium-Voltage (2700V) Testing Series.
- Hearing protection should be included as part of PPE.





# Light

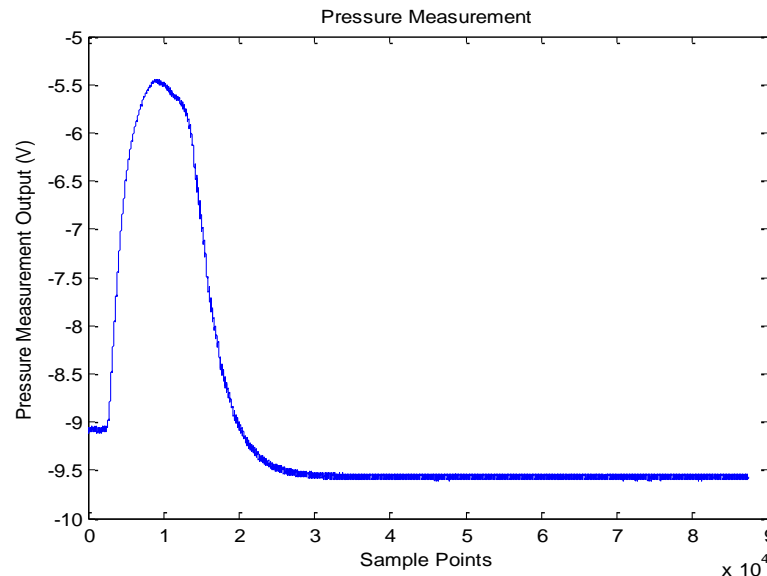
- Recorded light intensity level in lux at 3m, 4.5m and 6m from the arcing point.



**Typical bright sunlight is around 110K lux**

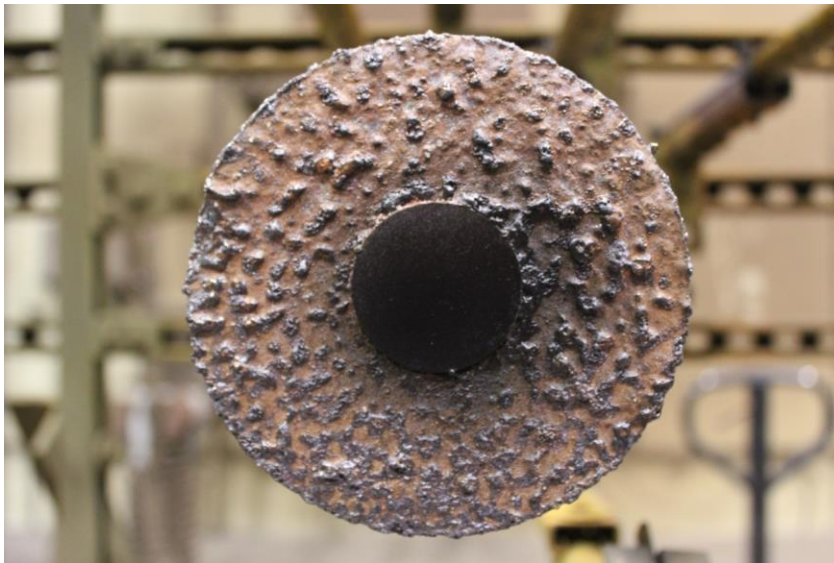
# Pressure

- Sample results of pressure measurement
  - The estimated pressure reached 0.715 psi (103 lbs/ft<sup>2</sup>) at the working distance of 18”



# Something That Calorimeter Can Not Measure

- Face Shield is Recommended for Environment that Arc Flash May Happen



Copper on the surface of the insulation Board of the calorimeter



Lens was damaged by the melted copper.  
(10 feet from the arc point)



# **Simulation of DC Arc Flash**

# DC Arc Flash Simulation

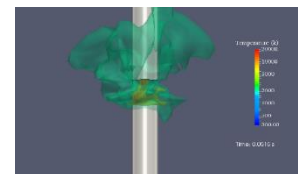
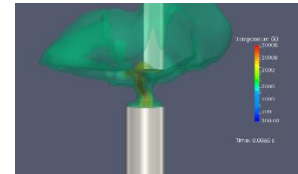
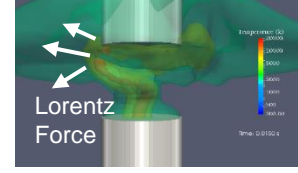
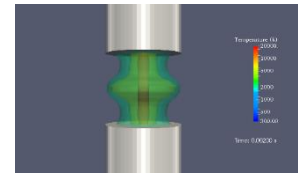
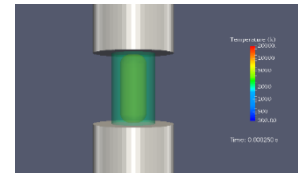
- System Voltage: 480V, Bolted Faulted  
Current: 21744A, Gap: 25.4mm

Electrode			
Description	Arc Current (Amps)	Arc Voltage (Volts)	Arc Power (kW)
KEMA Arc Test	15.81	131	2.071
Theoretical Method (Maximum Power Method)	10.872	240	2.609
Iterative Method (Stokes and Oppendlander)	16.89	107.25	1.811
MHD Simulation	16.00	126.76	2.028

Gap

Faraday Cage Arc Flash Test

Electrode



480V, 20kA, 1" Gap Arc Flash Test

# Thank You !!!

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